


CA20N
NR
-F56
GOVT

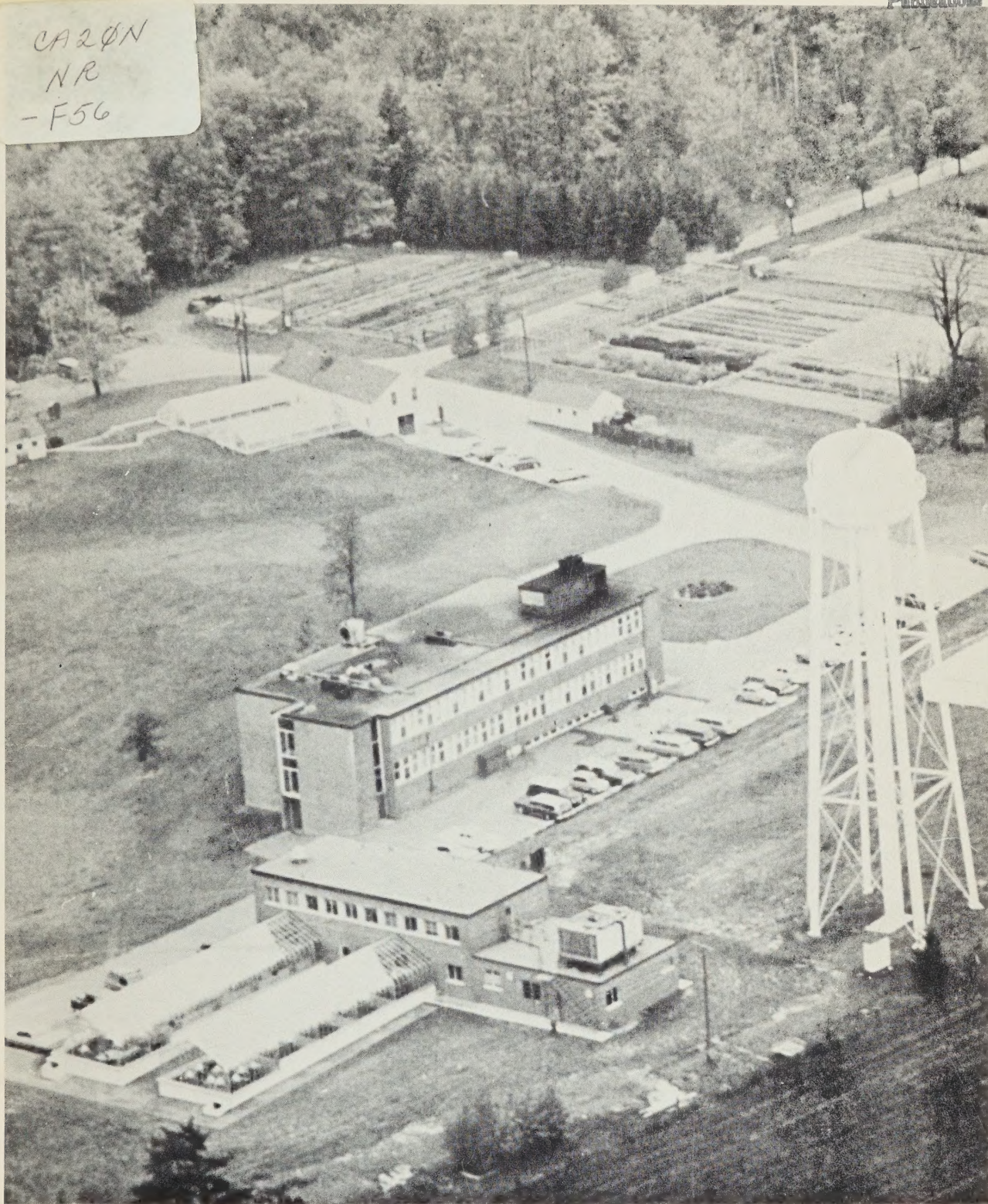


Digitized by the Internet Archive
in 2022 with funding from
University of Toronto

<https://archive.org/details/31761115475691>

①

CAZON
NR
- F56



Forest Research 78



Ministry of
Natural
Resources

Hon. James A. C. Auld
Minister
Dr. J. K. Reynolds
Deputy Minister

FOREST RESEARCH 78

Ontario Forest Research Centre
Ministry of Natural Resources
Maple, Ontario LOJ 1EO

1979



Ministry of
Natural
Resources

Hon. James A. C. Auld
Minister

Dr. J. K. Reynolds
Deputy Minister

CONTENTS CONTENTS CONTENTS CONTENTS CONTENTS CONTENTS CONTENTS CON-

- 1 INTRODUCTION
- 7 NEW PUBLICATIONS
- 11 CONIFER STOCK FOR ARTIFICIAL REGENERATION Jack pine seed yield and quality Monitoring white spruce seed production Cone harvester Use of shelters to improve seedling quality Pregermination in a greenhouse transplant system Pregerminated seed Automation of greenhouse transplant system Sphagnum moss 'cigarettes' Biodegradable container material Seedling harvester modified Packaging of nursery stock Clay-dipping of bare root stock Nursery treatments affect survival and growth of white spruce ...And of black spruce Extension of the planting season for black spruce Frost hardiness and dormancy Irregular performance of outplanted red pine Red pine seedlings vs transplants Transplants still better Ontario tubelings can grow well Nursery stock characterization Scarification equipment Silviculture equipment catalogue
- 21 HYBRID POPLAR FOR VARIOUS USES Objectives and methodology of breeding program Clonal propagation Prospects for new clones Poplar chemotaxonomy Assessment of root primordia on cuttings Assessment of nutrient requirements Site relationships Poplar harvester Biomass studies of poplar farming Biomass prediction models Nutrient drain Proteins for animal and human consumption Poplar as a fuel source
- 27 CONIFEROUS TREE IMPROVEMENT AND BREEDING Change in method of selecting and reproducing black spruce plus trees Spruce seed orchard material Spruce outplantings hit by drought White spruce provenance trials New spruce hybrids achieved Hybrid growth maintained Piceta Selection and preservation of white pine for genetic improvement White pine hybrids and clonal variation Pitch pine hybrids Variation in red pine Rooting of hard pine cuttings Growth of Austrian pine under extended photoperiod Larch improvement program Flower induction in larch
- 36 THE NORTHERN FOREST Forest drainage and fertilization increase forest growth Soil moisture on black spruce cutovers and plantations Herbicides release balsam fir Balsam fir succession Thinning balsam fir Root decay and stain may not influence growth rate of balsam fir Quality and variability of aspen regeneration

TENTS CONTENTS CONTENTS CONTENTS CONTENTS CONTENTS CONTENTS CONTENTS

- 40 UNDERSTANDING THE HARDWOOD FOREST Yellow birch regeneration Quality dynamics of maple stands Recruitment dynamics of sugar maple Sugar maple decline Packaged information on tolerant hardwoods Stand development in the tolerant hardwood forest Growth analyses of black walnut Lowlands in southern Ontario Elm breeding and propagation Hardwood improvement on upland sites Establishment on upland sites Diameter growth in sugar maple plots Basswood to sugar maple regeneration Oak to pine Maple sap studies
- 49 SITE AND PRODUCTIVITY Soil and site classification Site extension programs Spot testing kit Plantation standards Permanent sample plots in hardwoods and conifers Red pine tables refined Thinning trials in natural white pine stands Ontario Wood Supply and Forest Productivity model Hardwood stand growth model Productivity and nutrient cycling in spruce forest ecosystems

INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION

Ever since a formal forest research body was established within the Ontario government in 1941, the aim of forest research has been to provide scientific and technical knowledge required for the operating requirements of forest management. Through a series of reorganizations, this forest research body has become more intimately associated with forest management. Currently known as the Ontario Forest Research Centre (OFRC), it is now a large section in the Forest Resources Branch which, together with the Timber Sales Branch, comprise the Forest Resources Group of the Ontario Ministry of Natural Resources (OMNR).

The primary function of research is to provide new knowledge and understanding, and new techniques and materials needed to improve the management of trees and forests. The quest for knowledge and the application of it to achieve certain goals may be regarded as two ends of a chain, the links being the various activities. The closer the link is to the formulated goals, the more we may be inclined to talk about applied research or development. The further the links are from the ultimate goal, the more the work may be considered by some as basic and impractical. What counts, however, is that the chain of research activities is hooked in to management and each link performs an important role through drawing on the immense potential available.

When viewing research activities, managers often become impatient with the apparent complexities of scientific investigations and the time required to obtain results. "Knowledge" refers to an understanding of relationships and is more than data collecting or monitoring. The generation of sound knowledge requires time, as was pointed out in Forest Research 77. Furthermore, because research is dealing with unknown or less familiar situations, there is always a considerable amount of uncertainty and risk of failure or delay. To minimize the risk of inconclusive results, researchers attempt to use a systematic approach developed from theory, to employ sophisticated methodology, to do careful measurements with an eye for the unexpected, to analyze data objectively and to labour on concise and unambiguous reporting. Such an approach does take time, but results will withstand testing and minimize the risk for management.

INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRO-

The main function of forest management is to take new knowledge and make it work. When knowledge is lacking and the need is urgent, the best available information is used; adjustments and interpolations are made as deemed necessary. In addition, researchers are urged to help solve such current problems. The latter research may, however, because of the time lag, lead to results useful only to solve yesterday's problems.

The different functions of research and management, the need for reliable information to minimize risk for management, and the time-lag factor should all be reasons for bringing managers and researchers together. They can then formulate future needs, consider management and research capabilities, set objectives and develop appropriate work plans. This would lead to both effective research and effective management, and further co-operation between the two.

Current OFRC projects have two different origins. Many projects were developed in response to expressed management needs and are often tied in to practical problems of field procedures. Other projects involve the application to forestry of concepts and techniques used in other disciplines. The latter ones enrich the number of options available to forestry, but their application may meet with obstruction because they do not quite fit current procedures and thought patterns and are therefore considered less practical. Advances in forestry, however, are not only accomplished by improving current procedures, but perhaps even more so by the adoption of well thought out new but less familiar knowledge and innovations.

For the solution of many problems and for the development of new options for forest management, there is an increasing need for team work by researchers who are specialized in various disciplines. Therefore, two new research teams were organized in addition to the Poplar Culture Research Team (L. Zsuffa, leader) which was organized last year. The two are the Tolerant Hardwood Research Team (H.W. Anderson, leader) and the Artificial Regeneration Research Team (C. Glerum, leader). Each team has, in addition to the researchers, at least one field forester as a member.

DUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION

To improve the efficiency of internal administration of OFRC, the 10 rather small units at Maple were regrouped into 4 larger ones representing major disciplines: tree breeding, silviculture and tree biology, site and productivity, and mechanical. The 4 field research units were not affected.

A formal study register was initiated to improve the formulation of problems, setting of objectives, development of strategies, program planning, reporting of progress and provision of an overview of OFRC activities. Most scientists have described their work and organized it into two to four "Fields of Study" statements, each comprising several "studies". Each study is usually made up of many experiments and activities, but these are not described in detail in the register. The register is kept simple because the available manpower in research administration is very limited. Review processes will be developed (one steering committee has been active for some years) and participation by field managers is planned.

Progress in some areas of research, particularly those of long term duration dealing with complex problems and large areas such as in mensuration and site research, is being severely hampered due to complement restrictions. For short term research, usually dealing with smaller well specified problems, we have purchased research and development services in compliance with general government directives. Thus, contracts have been let to companies for developing and constructing silvicultural equipment and to individuals and universities for undertaking specified projects. Some contracts related to hybrid poplar research for the Eastern Region were financed from DREE/TEIGA funds made available according to an agreement between the Canada Department of Regional Economics Expansion (DREE) and Ontario Ministry of Treasury, Economics and Intergovernmental Affairs (TEIGA).

Scientists have been active in national and international organizations such as International Union of Forest Research Organizations (IUFRO), International Energy Agency (IEA), North American and Canadian Poplar Councils, and others. These organizations are sources of information and provide opportunities

INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRO-

for development of ideas which are relevant to the Ministry's responsibilities. Many OFRC researchers assisted the Forestry Faculty of the University of Toronto this year by giving lectures and guiding seminars.

As part of cooperation with Great Lakes Forest Research Centre (GLFRC) and Petawawa Forest Experiment Station (PFES) through the Canada-Ontario Joint Forest Research Committee (COJFRC), OFRC organized a Tree Improvement Symposium in Toronto with a one day field trip. A total of 149 persons participated, mainly forest managers of the Ministry, but there were also representatives from the Canadian Forestry Service (CFS), other provinces, universities and companies.

Much of our research work requires province-wide field activities such as outplantings, plot maintenance and protection, and in some cases field measurements. The active participation by regions and districts in cooperative research programs is again gratefully acknowledged.

I wish to acknowledge the substantial contribution of David Fayle as the editor of this and the six previous annual reviews of OFRC research. He has again organized material submitted by individual researchers into a report which, if past demands are any indication, will find its way not only to managers in Ontario, but also to many others outside this province.

D. Burger
Head, OFRC

Research staff The only change in the professional staff this year was the appointment of Dave Weingartner to the Northern Forest Research Unit at Thunder Bay, to undertake research on aspen silviculture. Rodney Smith was taken on contract with OFRC to develop a catalogue of silvicultural equipment.

The following is a listing of the professional, technical and secretarial permanent staff of the Ontario Forest Research Centre, as at the end of 1978.

DUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION

MAPLE OFFICE

Administration D. Burger, AgrEng(For), PhD
E.M. Beckwith, M. Johnstone, P. Mueller

Silviculture and Tree Biology C. Glerum, BScF, MScF, PhD (Leader); H.W. Anderson, BScF, MScF; D.C.F. Fayle, BScF, DipFor, PhD; P. Jaciw, BScF; H.C. Larsson, BSA, BScF, MScF; D.A. Skeates, BScF, MScF; G. Stroempl, DiplForstwirt; V.H.H. Williamson
G. Bain, W.J. Beekers, J.G. Boufford, D.E. Irving, J. Tonge

Site and Productivity G. Pierpoint, BScF, MScF (Leader); A.F. Beckwith, BScF, MScF; R.H. Leech, BScF, MScF; F.L. Raymond, BS, AM. PhD; J.F. Robinson
C. Gocool, O. Kent, Y-T. Kim, BSc, MSc, A.A. Morris, J.M. Paterson, P.A. Sayers, L.J. Spence, J. Stoddart, T. Taylor

Tree Breeding L. Zsuffa, BScF, PhD (Leader); G.P. Buchert, BSc, MSc; K. Eng, BSc(For), MSc; R.M. Rauter, BScF, MScF
K. Bennett, D. Boufford, D. Gamble, M. Leggat, G.H. Saul, M. Weishar

Equipment Development A.L.M. Citro, BScF
R.H. Foote, C. Hopkinson, N.G. Mishrigi

FIELD OFFICES

Midhurst R.E. Mullin, BScF, MScF, PhD
L.J. Bowdery, R. Hutchison

Dorset M.M. McLean, BScF
W. Ohlmann, I.W. Palmer

Sault Ste. Marie A.G. Gordon, BScF, PhD
N.C. Jondreau, T.H. Lussier

Thunder Bay N.F. Lyon, BScF (Supervisor); R. Forslund, BM; A. Lehela, BScF, MScF; K.M. McClain, BScF, MScF; D.H. Weingartner, BScF, MScF
L. Bye, T. Casella, G. Page

ADDRESSES

Ontario Forest Research Centre
Ministry of Natural Resources
Maple, Ontario LOJ 1EO
Tel: (416)832-2761 Telex: 06-964589

INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION INTRODUCTION

Midhurst Research Unit
Ministry of Natural Resources
Midhurst, Ontario LOL 1X0
Tel: (705)726-7640

Central Research Unit
Ministry of Natural Resources
c/o Box 490
Sault Ste. Marie, Ontario P6A 5M7
Tel: (705)949-9461

Algonquin Research Unit
Ministry of Natural Resources
Box 190
Dorset, Ontario POA 1EO
Tel: (705)766-2671

Northern Research Unit
Ministry of Natural Resources
Box 2960
Thunder Bay "P", Ontario P7B 5G5
Tel: (807)767-1607

COVER PHOTOGRAPH

The main buildings of the Ontario Forest Research Centre at Maple are shown on the cover. Part of the tree breeding nursery is visible in mid upper centre and right of the photograph.

NEW PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS

Copies of publications listed below may be obtained by circling the appropriate number on the addressed card included with this report.

1. BECKWITH, A.F. and (W.S. McNEICE). 1978. Guides to growth in red pine plantations, p. 141-155. In D.A. Cameron (compiler). White and red pine symposium. Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario. Symposium Proceedings O-P-6.
Figures and tables are presented and discussed concerning thinning of plantations and estimation of growth.
2. BUCHERT, G.P. 1978. Hard pine improvement in Ontario, p. 85-86. In Proceedings 16th Canadian Tree Improvement Association Meeting, Winnipeg, Manitoba, June 27-30, 1977.
Summary of hard pine improvement studies.
3. FAYLE, D.C.F. 1978. Poor vertical root development may contribute to suppression in a red pine plantations. The Forestry Chronicle 54: 99-103.
The 30-year height growth and extension of the main horizontal and vertical roots of red pine trees that became suppressed is compared with those that became codominants.
4. FAYLE, D.C.F. and G. PIERPOINT. 1978. Interpreting performance of recently outplanted pine seedlings, p. 113-121. In D.A. Cameron (compiler). White and red pine symposium. Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario Symposium Proceedings O-P-6.
Shoot and root development of red pine are discussed to provide a foundation for understanding problems of performance after outplanting.
5. GORDON, A.G. 1978. Genecology and the contribution of genetic variation to productivity systems in spruce forest ecosystems, p. 89-91. In Proceedings 16th Canadian Tree Improvement Association Meeting, Winnipeg, Manitoba, June 27-30, 1977. Part I.
Summarizes the work undertaken in 1975-76 in spruce genetics.
6. (HUNT, K., J.T. BASHAM) and J.A. KEMPERMAN. 1978. Kraft-pulping evaluation of decayed trembling aspen (*Populus tremuloides*) from Ontario. Canadian Journal of Forest Research 8: 181-187.
Compares yield and strength characteristics of pulp from three common stem defect types in aspen with pulp from sound aspen.
7. KEMPERMAN, J.A. 1978. Sucker-root relationships in aspen. Ontario Ministry of Natural Resources, Forest Research Note No. 12. 4 p.
Discusses some common relationships between parent aspen roots and subsequent root sucker development as a basis for intensive management systems.
8. KEMPERMAN, J.A., (S. NAVRATIL and J.T. BASHAM). 1978. Preliminary assessment of defect variation among aspen clones in northern Ontario. Ontario Ministry of Natural Resources, Forest

NEW PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS NEW

Research Report No. 104. 9 p.
Compares type and extent of stem defect and average tree growth over 20 aspen clones as a preliminary justification for the development of a clonal management system.

9. LARSSON, H.C. and P. JACIW. 1978. Potential for growing nut pines in Ontario. Ontario Ministry of Natural Resources, Forest Research Note No. 13. 4 p.
The characteristics of Korean pine, Siberian stone pine and dwarf stone pine are described and the possible use of these species in Ontario is discussed.
10. LARSSON, H.C. and P. JACIW. 1978. Prospects for growing Asian nut pines in the temperate and boreal forests of North American, p. 90-95. In 69th Annual Report of the Northern Nut Growers Association.
There is every indication that the three Asian nut pines (see Publication 9) can be successfully grown on similar sites in the temperate and boreal forest zones of North America, as in their native habitat in Asia.
11. MULLIN, R.E. 1978. Plantation performance averages for white spruce. Ontario Ministry of Natural Resources, Forest Research Note No. 15. 2 p.
An empirical presentation of the results of research plantings in terms of survival, height and aggregate height (m/ha) from 0 to 20 years to aid in the assessment of local plantation performance.
12. MULLIN, R.E. 1978. Plantation performance averages for red pine. Ontario Ministry of Natural Resources, Forest Research Note No. 16. 2 p.
(As above.)
13. MULLIN, R.E. 1978. Root exposure, root dipping and extended spring planting of white pine seedlings. The Forestry Chronicle 54: 84-87.
A test of root exposure from 0-3 hours of white pine seedlings was run in spring 1971 for a 10-week period, also testing the effects of water dipping. Exposure resulted in damage, more so as the season advanced. Water dipping was of no benefit for this species. Extended season planting resulted in reduced growth of the plantation.
14. MULLIN, R.E. 1978. Plantation performance averages for white pine. Ontario Ministry of Natural Resources, Forest Research Note No. 18. 2 p.
(As above.)
15. MULLIN, R.E. 1978. Plantation performance averages for black spruce. Ontario Ministry of Natural Resources, Forest Research Note No. 19. 3 p.
(As above.)
16. MULLIN, R.E. 1978. Tests of frozen spring storage for white spruce and red pine planting stock. U.S. Forest Service, Tree Planters' Notes 29 (4): 26-29.
There was a very short period in early spring when white spruce could be lifted for successful frozen storage; the period was slightly longer for red pine. Stored white

PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS NEW

spruce was used to extend the planting season by a week or two, but stored red pine was subject to growth loss and a shorter successful planting season.

17. MULLIN, R.E. 1978. Effects of cultivation after planting in establishment of white spruce plantations. VII World Forestry Congress: 2174-2176.
Pre- and post-planting cultivation obtained significantly better survival and growth than pre-planting cultivation only (more than twice the survival rate, 13% taller trees).
18. MULLIN, R.E. and L. BOWDERY. 1978. Effects of nursery seedbed density and top-dressing fertilization on survival and growth of 3+0 red pine. Canadian Journal of Forest Research 8: 30-35.
A lower seedbed density (160 vs 320 trees/m²) gave larger, better balanced trees for outplanting, resulting in higher plantation survival and better growth. The normal nursery fertilization procedure was found damaging to performance after outplanting.
19. MULLIN, R.E. (and L.J. FORCIER). 1978. Mid-winter grading of frozen nursery stock in storage. Ontario Ministry of Natural Resources, Nursery Notes No. 52. 4 p.
Two containers (Kraft-polyethylene bag and the polybin) were used in a test of mid-winter grading of frozen jack pine shipping stock. Results showed that the grading was damaging, the polybin was a better storage container, and water dipping before storage was harmful.
20. MULLIN, R.E. and R.E. HUTCHISON. 1978. Fall lifting dates, overwinter storage, and white pine seedling performance. The Forestry Chronicle 54: 261-264.
A further study of Degree-Hardening-Days recommended the use of 165 DHD (base 10°C) as safer than an earlier suggestion of 125 DHD for overwinter storage.
21. MULLIN, R.E. and R.E. HUTCHISON. 1978. Lifting guides for frozen overwinter storage of black spruce at Swastika nursery. Ontario Ministry of Natural Resources, Nursery Notes No. 55.
Guides are given for lifting black spruce for frozen overwinter storage at one nursery.
22. PIERPOINT, G., J.M. PATERSON, J.G. BOUFFORD and C. GLERUM. 1978. Irregular growth of outplanted red pine. III. The influence of handling and planting on second-year performance. Ontario Ministry of Natural Resources, Forest Research Note No. 14, 4 p.
Results after two years continue to suggest that transporting, handling and planting techniques used in normal operations contribute significantly to a reduced performance of outplanted 3+0 seedlings.
23. RAUTER, R.M. 1978. The genetic improvement program of spruce and larch in Ontario, 1975-76, p. 99-101. In Proceedings 16th Canadian Tree Improvement Association Meeting, Winnipeg, Manitoba, June 27-30, 1977.
Summary of work done in 1975-76.
24. RAUTER, R.M. 1978. Vegetative propagation. In Proceedings 25th Annual Northeastern Forest Tree Improvement Conference, Orono,

PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS NEW PUBLICATIONS

Maine, July 25-29, 1977. 14 p.

Describes grafting techniques and rooting of cuttings for the field forester.

25. RAUTER, R.M. 1978. Women in Canadian forestry -- from a suppressed past to a promising future. Invited paper, 8th World Forestry Congress, Jakarta, Indonesia, October 16-18, 1978. 8 p.
Women were a rarity in Canadian forestry in the past, but there are many more now. Although a few problems still exist, the situation has and should continue to improve.

26. STROEMPL, G. and A.F. BECKWITH. 1978. A successful red oak--red pine plantation. Ontario Ministry of Natural Resources, Forest Research Note No. 17. 3 p.
The relative height and diameter growth of red oak and red pine in a mixed plantation is discussed. The mixture provides an alternative to pure pine plantations.

27. ZSUFFA, L. 1978. Poplar and white pine breeding at Maple in 1975 and 1976, p. 103-106. In Proceedings, 16th Canadian Tree Improvement Association Meeting, Winnipeg, Manitoba, June 27-30, 1977.
A summary of activities and results.

CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR

Production and minimum wastage of seed are important in nursery systems, whether for use in raising bare root or container stock material. Studies continue on nursery practices, lifting and storage procedures; and the survival and growth of outplanted trees.

- | | |
|--|---|
| <i>Jack pine seed yield and quality</i> | As part of the seed research program, a study was undertaken in various stands of jack pine (<i>Pinus banksiana</i>) in Gogama District. Five dominant and codominant trees were sampled in forty 0.04 ha plots. Cones were collected by years of production in each tree. Cone measurements and total seed weight assessments were completed in 1978. (Baker*) |
| <i>Monitoring white spruce seed production</i> | The Orono white spruce (<i>Picea glauca</i>) seed production plantation (6203) has been assessed annually since 1971. Despite a poor white spruce seed crop through most of Ontario in 1978, 71 trees of a plot of 1068 trees produced a crop sufficient to sample. Of these 49 were actually collected, as cone crops on some trees were completely wiped out by insect or rodent attack. Seed and cone assessment is continuous. (Skeates) |
| <i>Cone harvester</i> | A preliminary feasibility study is under way to determine the mechanical design features necessary for the development of a cone harvester for black spruce (<i>Picea mariana</i>). (Citro) |
| <i>Use of shelters to improve seedling quality</i> | Corrugated plastic shelters developed last year were tested in the field as protection for seed beds at time of germination and during the early weeks of plant development. Jack pine in Swastika nursery, sampled in the fall of 1978, indicated 60% heavier 2+0 plants as a result of this early protection. Greater gains might be possible if shelters were in place earlier in the spring to allow earlier germination and hence a longer growing season. A modification of the shelters to provide protection over seed drills only was also reported last year. White pine |

*Graduate student, University of Toronto. Study was conducted under contract in Gogama and at Maple. Technical guidance D.A. Skeates.

ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER

(*Pinus strobus*) sampled in the fall of 1978 at Orono indicated a 35% gain in total dry weight after 2 years due to early protection. However, one-year-old white pine under shelters was a complete failure this year, due to a dry year and a design providing little access for water from rainfall or the irrigation system. A modification will be made for trials next year.

Red pine (*Pinus resinosa*) initiated under seed drill shelters at Orono in 1978 showed a 40% gain in total dry weight after the first year's growth. However, in an area where shelters were in position in the fall and hence provided warmth and protection very early in the growing season, 1-year-old plants were more than double the total dry weight of adjacent control beds, though no taller than in beds protected in the spring. A gain of 64% in dry weight of 1-year-old black spruce resulted from protection at Swastika. No gains were evident in white spruce. Again, greater gains may be possible by earlier establishment of protection.

Pregermination in a greenhouse transplant system

Research with black spruce transplants, started as pre-germinated seed, has been finalized. Three projects have been successfully terminated. The results of the first, a time of sowing study at Orono, will be published shortly. Two other projects, completed in 1977 and 1978 respectively in Swastika nursery, have shown that 2-year-old black spruce, considerably in excess of the Ministry's size standards, are a feasible alternative to standard bare root transplant production. (Skeates)

Pregerminated seed

Work continued on pregerminated seed for use with automated equipment. A cellulose cigarette filter was tried as a germinating media and showed promising results. The radicle of a newly germinated seed had no difficulty in establishing itself in the cellulose fibre and providing adequate support for the hypocotyl. Once the radicle protruded from the bottom of the filter, the latter was planted into a growing media in a greenhouse to see how readily the seedling would develop. The first greenhouse trials indicated

STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION

that the seedlings rooted into the growing media without a set-back and new roots developed just below the filter soon after planting.

Automation of greenhouse transplant system

Concepts for automation of the complete process from manufacture of germination plugs of sphagnum moss cigarettes through to delivery of peat cubes with seedlings to the nursery for transplanting were presented at the International Plant Propagators' Society annual meeting (Skeates and Williamson). Development work from concept stage to operation is continuing. (Williamson)

Sphagnum moss 'cigarettes'

A Johnson & Johnson teabag material was reported earlier as maintaining adequate stability. However, used as a container material under greenhouse conditions (with growing trees in a closely packed configuration, regular watering and fertilization), the covering deteriorated within 6 weeks. Deterioration was not as rapid when cigarettes were placed in compartments divided in a grid pattern. Root tips of jack pine extended through the material but elongated only a few millimetres into the adjacent air space. Despite the weak nature of the covering, cigarettes were easily handled by the stem of the plant as in most plug systems. Summer-planted jack pine in these containers, sampled in November, had roots that had developed over the full length and circumference of the container, fully exploiting the adjacent soil. (Skeates)

Biodegradable container material

A biodegradable plastic recently introduced to the Canadian market is being tested for possible use as a material for containers. It is a polyethylene film with a specially treated corn starch filler added and is claimed to break down when buried in the ground. The material being tested has approximately 10% corn starch filler with an estimated break down period of one year. Another supply of the material with a 20% corn starch filler is being prepared, and will be tested when available.

CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL

Also being tested for the same purpose is a paper product made with combinations of synthetic pulp and wood pulp. The material was designed to simulate that used in the Japanese paper pot containers.

All materials being tested are for possible use in a modified "Moulin Mk VI" Cigarette machine that produces containers 2 cm in diameter and filled with peat moss.

(Williamson)

Seedling harvester modified

Improvements were made in two problem areas on the Seedling Harvester which is designed to lift seedlings from nursery beds.

Firstly, extensions were added to the existing root shakers so that the removal of soil from the roots would be more satisfactory. Secondly, the channels which support the V-belts that convey the lifted seedlings from the front to the rear of the Harvester were made more rigid. Additional V-belt rollers were also added. The combined effect of these modifications will be to increase the "squeeze" effect of the V-belts to prevent seedlings from falling out of the grasp of the belts. The Harvester will be tested in the spring of 1979. (Foote)

Packaging of nursery stock

Results of a test at Midhurst using Kraft-polyethylene bags and 'Plant Fresh' bags for overwinter storage showed that there were not significant differences between stock stored in the different containers at five years. Also there were no differences due to the trees being tied in bundles with elastic or string, or simply loose in the bags. In another test, water dipping of trees lifted in the fall for frozen overwinter storage and for cool storage in the spring was found of no benefit, and sometimes damaging (red and white pine). Another test of white spruce, white pine and red pine in overwinter frozen, spring cool and spring unrefrigerated storage at Midhurst showed that sphagnum moss in the package was unnecessary.

Clay dipping of bare root stock

The fifth-year survival and growth data were examined for a plantation which contained tests of root dipping (kaolin

REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR

clay slurry) of white spruce, red pine and white pine.

The tests had been conducted over several years and included periods of unrefrigerated holding of nursery stock in Kraft-polyethylene bags for up to 3 weeks. The results showed that the clay dipping was of no benefit and was sometimes damaging to the performance of the outplanted stock.

(Mullin)

Nursery treatments affect survival and growth of white spruce

Last year it was reported that white spruce seedling stock was raised in the Thunder Bay Nursery during the rising 2+0 and 3+0 years at 4 levels of N fertilization and 3 levels of density. This stock was then planted and nursery pretreatment effects have been assessed for the second year. Analyses to date indicate that second year survival of spring lifted stock is significantly better than fall lifted stock (86% vs 79%) and that fertility and not density significantly affected survival rates. At low and medium density with increased N supply survival decreased rapidly for both fall and spring lifted stock but at high density survival varied erratically with N supply. Current height increment followed much the same pattern as survival in relation to time of lifting, density and fertilization. From the results, white spruce seedling stock can be effectively preconditioned in the nursery by cultural practices which exert a strong influence on post planting survival and growth.

...And of black spruce

Similar work in black spruce was undertaken with the establishment of an identically designed plantation close to the white spruce plantation. Survival was not affected by any of the main treatment effects or any of the first order interactions. However, analysis of current height increment indicates that the effects of time of lift, density and fertilization were highly significant. In contrast to the second year results in white spruce, fall lifted stock performed better overall than spring lifted stock, i.e. 9.45 cm vs 7.65 cm. Within each classification of stock (fall and spring lifted) growth generally increased with

ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER

increasing N supply but decreased at the highest level of N supply. Survival and growth trends will be followed for the next four years. As with white spruce, it appears that black spruce stock can be preconditioned by nursery cultural treatments to influence survival and growth. It is important, however, to emphasize that because of the apparent survival and growth differences in white and black spruce, nurserymen should be cautioned against blanket applications of soil amendments without regard to species and preconditioning effects.

Extension of the planting season for black spruce

Plantations established during the frost free period of 1975-77 to elucidate the effects of deferred planting on survival and growth were again assessed. Trends in survival have changed little, if at all, from last year. Survival percentages for both spring lifted and stored, and fresh lifted transplant black spruce stock have remained high (greater than 90%) up until the end of August; thereafter, survival of freshly lifted stock increased with further deferment in planting until late October but decreased dramatically to 4% for stored material. Similar trends in survival but at slightly lower rates were recorded for freshly lifted and spring stored seedling black spruce stock.

Current height growth increments, although maintaining differentials between plantings within a stock type, increased over values recorded in 1977. Current height increments for the stored transplant stock planted up until the end of July averaged 12% greater than that for the freshly lifted and planted stock. Except for the first planting at the end of May, freshly lifted seedling stock did as well or better than the spring lifted and stored stock.

Although the performance of these plantations will continue to be monitored for the first 5 years it would appear that with careful lifting, transport and planting and prudent choice of sites the planting of black spruce may be successfully extended beyond the conventional time periods.

STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION

With further analyses recommendations will be presented on the choice of stock, sites and duration of the planting period to effect maximum survival and subsequent rapid and continued growth. (McClain)

Frost hardiness and dormancy

The dormancy and frost hardiness of planting stock can be measured by electrical impedance techniques. The testing of the electrical impedance prediction equations was continued at Orono Nursery. White spruce and white and red pine, lifted for cold storage on three predicted lifting dates in October and November 1977, were outplanted in the spring of 1978 and compared with freshly lifted trees. Survival in the fall of 1978 was low for all species and treatments due to severe drought conditions encountered in the summer of 1978. Three lifting dates were selected in the fall of 1978 and the impedance values predicted for these dates were again similar to the actual measurements at lifting. Due to the variability of the electrical impedance measurements it is planned to see if correlations exist between impedance and degree-hardening-days. (Glerum)

Irregular per- formance of outplanted red pine

Third-year survival and height-growth data were collected from the outplanting plots established in 1976 to test whether nursery stock quality or the typical field handling and planting technique used by district crews is the major factor contributing to the unsatisfactory survival and growth of red pine observed in field plantings. The first- and second-year data have shown reductions in survival and height growth which were attributable to field handling and planting techniques. This trend continued through the third year. In a majority of the district crews' plantings (but not all), mortality was greater and height growth was less than in the controlled plantings by research crews. Pooling all district crews' data and all research crews' data shows survivals after three years of 74% and 90% respectively, and a height-growth total (sum of the 3 years' growth of all trees now surviving) for the "research" trees that is 51% greater than that of the "district" trees. Monitoring will continue. (Pierpoint and Glerum)

CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL

*Red pine
seedlings vs
transplants*

In the spring of 1978, red pine of age classes 3+0, 1+2, 2+1 (Orono only) and 2+2 from Orono and Midhurst nurseries were outplanted at Vivian and Larose Forests. The purpose of the plantings was two-fold: to see if other age classes of red pine showed similar growth development and performance as the 3+0 age classes commonly used, and to test the 1+2 age class which is a new age class for red pine. In both first year survival and height growth the 2+2 and 1+2 age classes performed significantly better than the 3+0 age class. This significant difference was noted at both outplanting locations. The results are to be published as a Forest Research Note in 1979. (Glerum)

*Transplants
still better*

The 20th year results of a seedlings versus transplants experiment for white spruce, red pine and black spruce showed again the superior performance of the transplants. As an example, the 3+0 white spruce at Kenora produced 13.9 m²/ha of basal area at 20 years whereas the 2+2 stock produced 23.4 m²/ha, or 68% more. Further information on the 20th year performance will be obtained in 1979 and the data related to standard volume tables. The second-year results of a study with black spruce at Swastika Nursery showed that the transplants (1½+1½) produced about 20% more terminal growth than did the 3+0 stock in the same experiment. (Mullin)

*Ontario tube-
lings can grow
well*

In northern Ontario, root development in black spruce raised in Ontario tubes and planted with and without the tube (i.e. as a plug) was studied in relation to tree growth. Those trees planted as a plug had a symmetrical root system and height growth increment increased rapidly after planting. Trees planted with the tube on were classified according to the presence or absence of adventitious roots. Those tubelings which failed to develop adventitious roots exhibited a very restricted root form and depressed growth, while those that developed adventitious roots grew as well as and possibly better than the plugs. It was concluded from this study that the

REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION CONIFER STOCK FOR

development of containers for regeneration purposes must accommodate the inherent silvical characteristics of species to be used, either in the manner of their construction or in the way in which the container is planted.
(McClain)

Nursery stock characterization

Top-root ratio determinations have been determined by oven-dry weight for years. In 1978 a volume displacement method was tried for determining top-root ratios. This method has two advantages over the oven-dry weight method: it is non-destructive so that the seedlings can be outplanted afterwards, and it can be done quickly. There is no need to wait for 24 or 48 hours while the trees are being oven dried. Although the volume displacement top-root ratios are larger than the oven-dry weight ratios the differences are consistent. It is concluded that the volume displacement method is a viable alternative to the oven dry weight method. A report is being prepared. (Glerum)

Scarification equipment

The rear-mounted CFS Scarifier is used in conjunction with a V-plow to prepare a pathway wide enough for planting two rows of seedlings. A unit was tested by the Timmins District, in the spring. Alterations, suggested in a report prepared by that District, are being done to further increase the efficiency of the Scarifier. Modifications are to be completed by the spring of 1979 for further trials at Timmins.

The Geraldton District has constructed a scarifier known as the "Little Big Foot". In response to a request to develop a more sophisticated prototype based on the same principle, the Mechanical Unit has begun preliminary design work on the MRU Scarifier.

The Scarifier will be designed to prepare harvested sites for planting or seeding. It will be mounted on a rubber-tired skidder which will make the unit manoeuvrable and easily transportable in order to achieve low site preparation costs, particularly on smaller areas. The hydraulic control features and interchangeable soil-working components will give the unit enough versatility for use on different site

ARTIFICIAL REGENERATION CONIFER STOCK FOR ARTIFICIAL REGENERATION

conditions.

Testing of a prototype is scheduled for the summer of 1979. (Mishrigi)

*Silviculture
equipment
catalogue*

To assist the management forester in broadening his or her knowledge and understanding of mechanized silviculture, work began in late 1978 on the compilation of a Silviculture Equipment Catalogue.

The catalogue will contain detailed physical, mechanical and operational specifications, as well as prices and photographic and graphic illustrations of all types of silviculture equipment used in Ontario. Also, based primarily on the experience of Ministry field staff, items of equipment will be assessed on their ability to perform under specific site conditions and on other critical operational considerations, such as ease of transport, availability and safety. (Smith)

HYBRID POPLAR FOR VARIOUS USES HYBRID POPLAR FOR VARIOUS USES

The development of suitable material for a variety of existing and potential uses is a fundamental part of the poplar program. Growth studies continue in an effort to determine the response of different clones to various cultural practices.

Objectives and methodology of breeding program

The main objective is to produce clonal stock for the various needs of an intensive poplar plantation program. Work concentrates on cottonwoods and their hybrids with black poplar (*P. nigra*) and different balsam poplar species (such as *P. balsamifera* L., *P. trichocarpa* Hook., *P. maximowiczii* Henry, *P. laurifolia* Ledeb., and *P. Simonii* Carr). These hybrids are generally easy to clone and propagate by rooting of stem cuttings, they establish readily in plantations, grow vigorously, and respond with increased growth to intensive management. Their biomass is valued for various uses.

The breeding and clonal development for all conditions and needs follows the same basic outline: (1) selections of native species are made, seed collected and gene pools of progenies established; (2) scions and seeds of desired exotic species are obtained and established in gene-pool plantations; (3) parent trees with desired traits are selected and hybridized; (4) the hybrid progenies are established in gene-pool plantations; (5) specimens possessing desired traits are selected from gene-pool plantations and cloned; (6) initial clonal trials are established (with large number of clones and small plots) in important planting areas; and (7) the best clones observed in initial trials are studied further and recommended for plantation trials.

Clonal propagation

There is a need for fast initial propagation of promising new clones, in order to multiply these in larger quantities for various studies and plantation trials. Small (2-8 cm long) stem cuttings and leaf-cuttings have been tried for this purpose. The cuttings were planted in small containers and kept in a greenhouse environment. Rooting occurred within 2 weeks, growth was fast, and new green cuttings

HYBRID POPLAR FOR VARIOUS USES HYBRID POPLAR FOR VARIOUS USES HYBRID

could be taken immediately from the rooted plants for further propagation. In this way, a single tree produced several hundred individual plants within one winter greenhouse period.

Cutting propagules are mass-produced in clonal stools. The clonal stools of poplars, which easily recoppice, are managed for the growth of juvenile, vigorous whips that are suitable for cuttings. Three types of stools are developed and maintained at OFRC and several OMNR nurseries: (1) The basic pool contains all clones which have been selected, propagated, hybridized and studied. This pool at OFRC contains approximately 1000 clones. (2) The clonal collection stools contain the clones of potential for large scale planting. The collections in Kemptville, Midhurst and Orono nurseries contain approximately 250 clones. (3) Production stools propagate large quantities of cuttings of certified clones for regular plantings. Presently, approximately 40 clones are used as such.

Prospects for new clones

Numerous hybrid progenies have been created. New clones are continuously being chosen and tested from these. The early performance of some (such as *P. deltoides*, Ontario x *nigra*, Hungary cl. DN55; *P. x Jackii*, Ontario x *nigra*, Hungary cl. JacN5) is very promising, and they are being propagated on larger scale and tested in production trials. Many qualities of the new clones, such as pest resistance and biomass, are being studied. Information is accumulating rapidly and several certified new clones can be expected for stock production within the next 5 to 10 years. (Zsuffa)

Poplar chemotaxonomy

Leaf polyphenols of 110 foliar samples from more than 50 hybrid poplar clones were analyzed in 1978 (DREE/TEIGA funding). A plastochron index selection method was used to compare material collected early and late in the growing season. The analytical technique was improved by using cellulose thin layer rather than paper chromatography. The prime objective is the development of a computer-oriented taxonomic map or key for at least groups of hybrid clones.

POPLAR FOR VARIOUS USES HYBRID POPLAR FOR VARIOUS USES HYBRID POPLAR FOR

A secondary objective is to identify possible genetic linkages between leaf chemistry and performance characteristics. In future studies, the use of gas chromatography to separate similar clones on the basis of quantitative as well as qualitative measures will be explored. (Anderson)

*Assessment of
root primordia
on cuttings*

Existing root primordia on stem cuttings of hybrid clones of *Populus alba* are not visible externally, but can be seen readily when the bark is peeled off. They appear as small, spindle-shaped projections on the surface of the wood; a corresponding depression occurs on the inside of the bark. The primordia are formed during the first year of growth and numbers per unit length decrease from base apex of the year's extension growth. Four stool shoots probably give enough data to assess the abundance of root primordia for a clone. The abundance of primordia, however, is not indicative of root development. Many primordia fail to develop into roots. These studies, which will continue, are part of a DREE/TEIGA funding contract with Dr. J.L. Farrar of the Faculty of Forestry and Landscape Architecture, University of Toronto. (Fayle)

*Assessment of
nutrient
requirements*

Three clones (DN76, DN19, DTacl) were grown in the greenhouse under controlled nutrition conditions to establish standards that will serve as guides in assessing nutrient requirements of outplanted poplars. Although all three clones were severely attacked by mites, they recovered after treatment with insecticides and resumed vigorous growth. (Leech)

*Site
relationships*

The study of growth of hybrid poplar in relation to site characteristics continued. Analysis of the data supported the previous findings that the only site factors, to date, which relate directly to growth are soil texture, moisture regime, pH and slopes. Several clones of hybrid poplar have grown better on sites that have a sandy loam soil, a 2 moisture regime, a pH between 6.2 and 7.4 and a slope of 1-5% than on sites with other characteristics. Detailed

VARIOUS USES HYBRID POPLAR FOR VARIOUS USES HYBRID POPLAR FOR VARIOUS USES

chemical analysis has not shown any direct relationships of one or more elements with the growth of specific hybrid poplar clones on specific sites. Until such relationships are established, chemical treatment for improved growth of specific clones on specific sites can be done only at an elementary level. (Sinclair)

Poplar harvester

A prototype Poplar Harvester has been designed and a pre-production model is now being built with the help of a consulting firm, under the aegis of the Eastern Region. A production test will be carried out in 1979. (Citro)

Biomass studies of poplar farming

Performance of several hybrid poplar clones growing in densely spaced minirotations was evaluated in terms of tolerance to unconventional harvesting methods. A cutting-thinning-defoliation (CTD) test established with 6 clones (3 aspen, 2 cottonwood, 1 Jackii) treated at 7 tri-weekly dates in 1977 was checked for response in July 1978. All clones showed good survival in spite of the intra-seasonal harvesting, with all 3 aspen having 100% survival and none of the other clones having less than 90%. All dead stools had been either cut or defoliated in early-to-mid July. Thinning of sprouts to leave only a dominant stem did not affect survival, regardless of treatment date. This is in contrast to the reaction of Euramerican clone I-45/51 to summer cutting. In a test of sequential thinning, defoliation and harvesting at 3 dates in 1977, survival was quite poor, ranging from 2.6% to 81.4%. This confirms the previous unsatisfactory experience with harvesting this clone during the vegetational period. Additional tests of seasonal harvesting have been set out.

A spacing x minirotation experiment established in 1972 with clone I-45/51 was remeasured in 1978. Survival after 7 growing seasons ranged from 62% to 95%, tending to increase with both rotation length (averaging 68% for 1 year rotation to 92% for 3 year rotation) and spacing (averaging 70% for 0.3 x 0.9 m to 95% for 1.2 x 2.4 m). Average dominant sprout height and diameter both increased with spacing.

HYBRID POPLAR FOR VARIOUS USES HYBRID POPLAR FOR VARIOUS USES HYBRID

Biomass values will be determined; these should indicate an optimum strategy for spacing and rotation for this clone growing in these conditions.

A close-spacing x clonal trial to be grown on a 2-year rotation was established at Midhurst in 1978. This includes 7 Euramerican clones (mostly new hybrids) planted at spacing ranging from 0.2 x 0.4 to 0.4 x 0.8 m. This experiment will expand information gained from a similar test (with different clones) established at Kemptville in 1977.

Biomass determinations were made on current sprout growth of coppice aspen clones AK30 and C147 growing at Kemptville. Seasonal height growth of dominant stems exceeded 3 m and oven-dry productivity averaged more than 10 t·ha⁻¹ in both clones. Dry matter production depended upon the rate of survival of the stools which were planted in 1973 at 0.3 x 0.9 m, and reached a maximum of 14 t·ha⁻¹ in the best-stocked plot. Some of the plots will be allowed to develop 2- and 3-year-old stems before the next harvest.

Biomass prediction models

Work was continued on the development of biomass prediction models for hybrid poplar. In the Allandale spacing x rotation experiment, sample sprouts of 1, 2 and 3 years of age growing at various spacings were harvested in September and subdivided into leaf, branch, and stem tissue for each internode. Oven-dry weights were obtained for each component and various physical stem measurements were made. A model under development will relate total stem, leafless stem and bole oven-dry biomass to physical stem dimensions, spacing, and age. Basic relationships of biomass/D²H were also routinely developed for some newer clones growing at Kemptville. Equations were computed to predict leaf area from measurements of leaf dimensions and also from leaf weight for various clones. Such data are being used in classical growth analyses of hybrid poplar, for example in the calculation of leaf area index and net assimilation rate.

POPLAR FOR VARIOUS USES HYBRID POPLAR FOR VARIOUS USES

Nutrient drain Tissue samples were routinely collected in most instances where clonal material was destructively measured. These are analyzed for elemental composition and results are correlated with biomass yield to allow estimates of nutrient drain associated with complete utilization.

Proteins for animal and human consumption Studies were continued on the quantity and quality of hybrid poplar leaf protein concentrate in cooperation with the University of Toronto. Leaf collections were made from 14 clones for the purpose of manufacturing bulk extracts suitable for rooster feeding experiments. Additional collections of leaves of several willow clones were made since previous analyses had indicated a high potential for some willow hybrids.

As a result of DREE/TEIGA funding, a cooperative study was begun with the University of Ottawa to characterize the main leaf enzyme protein in terms of molecular weight, biological activity, subunit structure and amino-acid sequence. The intention is to evaluate the potential of purified leaf protein as a food source for human consumption.

Poplar as a fuel source Further testing of the clonal variation in cellulose/lignin ratio of hybrid poplar wood was undertaken on 7 clones (3 aspen, 3 cottonwood, 1 Jackii) in cooperation with the University of Toronto. Two-year-old coppice stems are being analyzed.

The conversion of hybrid poplar wood into liquid fuel is also being studied jointly with the University of Toronto. High pressure, high temperature hydrogenation of wood meal produces about 40% oil and 60% gas, mainly methane. The heating value of the oil increased as the reaction time was lengthened. Current studies will evaluate the quality of the products and the cost-efficiency of the reaction.
(Anderson)

CONIFEROUS TREE IMPROVEMENT AND BREEDING CONIFEROUS TREE IMPROVE-

Ongoing studies in the selection and improvement of white and black spruce include the testing of plus tree selections, seed production areas and seed orchards. Hybridization work continues with various spruces. For the white pine breeding program, the objective is to develop genetically improved seed sources to satisfy the needs of an expanding reforestation program. This year, research reported on hard pines focusses on species other than jack pine. The larch improvement program is now in its third year.

Change in method of selecting and reproducing black spruce plus trees There is a change in emphasis in the method of selecting and reproducing black spruce plus trees. In cooperation with the Northwestern Region, plus trees of black spruce have been selected on the basis of the best tree over a given area rather than on a site-index curve basis. Instead of collecting scions, cones have been collected and kept separate on an individual tree basis. The tree breeding group has received a portion of the material. The seed has been extracted and the total seed, seed per cone and condition of the seed has been determined. The material will be germinated at the Dryden greenhouses and the best seedlings from the best families established in a seedling seed orchard. Some of the remaining seedlings will be established in progeny trials under normal field conditions. The remainder will be used as normal stock to meet the artificial regeneration requirement. This method of selection should enable large areas of seed orchards to be established in a relatively short period of time. It is hoped that this program can be extended throughout the north where black spruce is an important species.

Most of the trials are done in cooperation with the district and nursery personnel. It is anticipated that in the future many of the routine tests involving material selected by the districts will become part of the management program rather than be retained by research.

Spruce seed orchard material One-parent progeny trials for the black spruce 3W seed orchard were field planted in the spring of 1978 in the

MENT AND BREEDING CONIFEROUS TREE IMPROVEMENT AND BREEDING CONIFEROUS TREE

Ignace, Thunder Bay and Geraldton Districts. A fall tally indicated that there was little mortality in the 3 plantings but that many of the trees at Ignace appeared chlorotic or unhealthy, probably due to the dry, gravelly till site.

The first 2-parent progeny trial of the white spruce 3E seed orchard was germinated. The viability of the different crosses ranged from 4 to 95% with an average of 59%. These populations will be closely monitored throughout the nursery, greenhouse and field planting stages; the best material will form the basis of our second generation orchards. Additional controlled pollinations were carried out in 1978 and sufficient seed is available to start a second trial early in 1979.

Spruce out-plantings hit by drought

Material from the 6E white spruce seed production areas was field planted in the Lindsay, Huronia and Niagara Falls Districts. A fall tally indicated high mortality, particularly in Huronia, due to the extended drought during the summer months following planting.

Other spruce experiments planted in southern Ontario 4 and 5 years ago, that performed well through the 1977 season, also succumbed to the dry weather conditions.
(Rauter)

White spruce provenance trials

The early cooperative white spruce provenance trials (reported in 1975) were remeasured in 1978 by crews from Petawawa Forest Experiment Station and the Ontario Forest Research Centre. Preliminary results from the Owen Sound and Dorset trials show, after 25 and 20 years respectively of growth from seed, strong indications of fast-growing southern Ontario sources and variability in growth from Ontario sources independent of the site regions currently in use as seed zones. Considerable maintenance work, i.e. cleaning and pruning, was completed by district staff. Data from all plantings assessed will be published as a special joint report of the two forest research groups involved. These early trials are basic to subsequent

IMPROVEMENT AND BREEDING CONIFEROUS TREE IMPROVEMENT AND BREEDING CONIFER-

regional and all-range studies currently being conducted; collections are complete in most areas with the exception of parts of site regions 2E, 3E and 6E. Only 5 collections were possible in 1978, mostly repeat collections in Lindsay and Napanee Districts. Stock has been or is being produced for all series except for 4 planned experiments in site regions 3E and 6E where work is delayed by inadequate and irregular seed production.

The first plantings of the program were completed with the help of district staff in Red Lake, Fort Frances and Kenora. Planting sites were selected and site preparation work completed in Dryden, Thunder Bay, Nipigon and Terrace Bay for planting of the second series in 1979. Progeny aspects being studied by Petawawa were initiated with selection of a planting site in North Bay district for planting in 1980. Because of the strong performance of southern Ontario sources in the early provenance trials, greater emphasis has been placed on locating and sampling remnant white spruce stands across the south. In cooperation with district staff aircraft and helicopter surveys have been conducted to identify further gene pools in Owen Sound, Cambridge, Huronia, Lindsay, Napanee, Brockville, Cornwall and Ottawa districts.

Experimental stock assessment in Dryden nursery has provided some preliminary indications of variation in white spruce growth relative to origin of seed. This is the first information available for the white spruce of northwestern and north-central regions. On the basis of these results recommendations have been made for location of seed production areas and seed collections for districts in the northwestern region. (Skeates)

New spruce hybrids achieved

Flowering was light for spruce in 1978 over much of Site Region 5 and some of the breeding areas could not be used. However, in the Sault Ste. Marie District flowering was moderate, as was the case in Site Region 6 to the south. Breeding work was carried out in both areas.

Nine interspecific crosses with controls were attempted

CONIFEROUS TREE IMPROVEMENT AND BREEDING

with several clones. Six interspecific crosses were successful. New ground was once again broken by achieving the first successful crosses of *Picea mexicana* x *P. rubens*, x *P. glauca*, and x *P. engelmannii*. All these hybrids are new to science.

Picea mexicana is one of the world's rarest tree species existing as a low latitude relic in one isolated mountain area in Mexico. The area was decimated by a severe forest fire only a few years ago and it is not known how many individual trees are surviving. *Picea mexicana*, which is very fast growing, bears affinity to *P. engelmannii* and *P. pungens*. As a consequence, it was thought that the species could possibly be usefully crossed with *P. glauca*.

The attempted crosses with *P. pungens*, however, were unsuccessful, as were those with *P. orientalis* with which it is not related. The *P. mexicana* x *P. glauca* and x *P. engelmannii* crosses had an unexpectedly low crossability. Very few seedlings were obtained, of which only the *P. mexicana* x *P. glauca* are still surviving. Despite the low crossability, the fact that it can be done indicates that further work could bear greater success. A most unexpected success, however, was with *P. mexicana* x *P. rubens*. These species are scarcely alike and belong by most criteria in widely different groupings in the genus. The crossability was moderate and a fair number of confirmed hybrid seedlings were produced.

Another attempted crossing, involving the Rosendahl (*P. mariana* x *P. glauca*) hybrid spruce backcrossed x *P. glauca*, was unsuccessful. Hybrid *P. glauca* x *P. sitchensis* were backcrossed with *P. glauca*; and *P. sitchensis* (as noted in Forest Research 77) were again crossed x *P. glauca*. Vigorous seedlings have been obtained in both cases.

*Hybrid growth
maintained*

Measurements from field testing 8 years after reciprocally crossing *P. rubens* x *P. omorika*, reveal that the strongly heterotic height growth of seedlings of this cross is being maintained. The hybrids are continuing to grow much faster than are progeny of intraspecific control crosses of the

CONIFEROUS TREE IMPROVEMENT AND BREEDING CONIFEROUS TREE IMPROVEMENT AND

parent species. As a result of this continuing field verification, a new group of seedlings is being produced from seed from the original cross. Viability of the hybrid seed remains high at 32%, only a slight drop after 8 years. This group of seedlings will be turned over to tree production for mass propagation.

Piceta

Work continues on the *Piceta* which are designed to study genetic systems in *Picea*, including, for example, productivity, nutrition, efficiency, etc. of a large number of spruce species, provenances and forms. This project has been selected by the Canada/MAB Committee as a Canadian activity within the UNESCO Program on Man and The Biosphere. (Gordon)

Selection and preservation of white pine for genetic improvement

The natural white pine stands are rapidly being depleted and the first task is to intensify the selection and preservation of outstanding natural stands and plus trees. In 1978, 28 new eastern white pine plus trees were selected in 4 forest regions, and 24 of these saved by grafting, thus adding to a total of 97 plus trees, 66 of which were saved by grafting. Progeny testing is in progress to establish the ability of the selected trees to produce improved offspring and to single out the best parents for seed orchards. The early (1 to 7 years) figures show large variation (up to 2-fold) in survival and height growth of the progenies and the unselected controls, suggesting a significant potential for genetic improvement.

Scions are collected from selected trees for their propagation by grafting in the winter and cones are collected at the time of ripening in the fall for progeny testing. Both of these collections can be difficult because of inaccessibility of the trees. It would be desirable, therefore, to combine the scion and cone collection. Trials conducted over 2 years showed that the grafting of scions collected in the fall, at the time of cone collection, was feasible.

BREEDING CONIFEROUS TREE IMPROVEMENT AND BREEDING CONIFEROUS TREE IMPROVE-

White pine hybrids and clonal variation

In southern Ontario, eastern white pine x Himalayan white pine (*P. griffithii*) hybrids show promise because of their rust resistance and vigorous growth. Several field trials have been established with this hybrid on a variety of sites. In the oldest trial, at 6 years of age, the hybrid white pine outgrew the eastern white pine control by 61%.

Cloning by rooting of cuttings provides a shortcut in breeding and can secure large, immediate genetic gains. A study of 8 clones showed clonal variation which amounted to 52% in tree height, 109% in tree diameter (dbh), 61% in branch length and 37% in branch angle. Clones of reliable rooting ability and good performance have been selected, and nursery orchards for the mass propagation of the same initiated. (Zsuffa)

Pitch pine hybrids

In May, 1978 a pollination program was carried out with the aim of backcrossing *Pinus rigida* x *taeda*, *P. rigida* x *elliottii* and *P. rigida* x *radiata* hybrids to pure *P. rigida* parents. In this way it may be possible to incorporate more hardiness from the *P. rigida* parent into backcross progeny, while at the same time keeping a certain amount of the hybrid vigor shown by the hybrid parent.

Pure pitch pines and hybrid combinations in plantations at Turkey Point were assessed for height in 1978. When height was expressed as annual average height growth from seed, *P. rigida* x *taeda* hybrids were fastest growing, followed by *P. rigida* x *elliottii* hybrids. However, the importance of seed source is apparent in the hybrid materials growing at Turkey Point, as not all hybrid combinations are growing as rapidly as some pure *P. rigida* sources.

In field trials established in 1977, the superiority of *P. rigida* x *taeda* and *P. rigida* x *elliottii* hybrids is quite evident. Average height of hybrid progenies in Huronia District is almost double that of pure *P. rigida*. Early results from this series of plantings also indicates the importance of selecting proper parental types for hybridization. Greater gains in growth and form will be achieved when fast-growing, cold-hardy *P. rigida* from Canada and the

MENT AND BREEDING CONIFEROUS TREE IMPROVEMENT AND BREEDING CONIFEROUS TREE

northeastern United States are combined with the relatively hardy *P. taeda* and *elliottii* parents from the northern part of these species' natural ranges.

Variation in red pine

Although growth differences among red pine seed sources are rather small, much variation is present in stem form and branching habit. A study was begun to determine the inheritance pattern of such traits in 1978. Clones with extreme fastigate and excurrent branching were crossed with several clones of intermediate branching habit. Seed from these crosses will be collected in 1979 for further evaluation.

Measurement of interprovenance hybrid plantations indicated significant differences in height among provenance hybrid combinations. In the northern test, planted in North Bay District, the crosses Manitoba x Vivian Forest, Lake Abitibi x Vivian Forest and Newfoundland x Vivian Forest were tallest, respectively, while in the southern test, the Newfoundland x Vivian Forest provenance hybrid was tallest, followed by Manitoba x Vivian Forest and Lake Abitibi x Vivian Forest, respectively.

Further evidence for genetic gains in breeding of red pine comes from two identical half-sib red pine progeny trials in Thunder Bay and Swastika. Here, 13 seedlots of northern red pine were outplanted in 1966. After 12 years, significant differences in average height were observed among the different families. Two trees from Red Pine Lake, Hearst District, had the tallest progenies (106-109% of the plantation means at Thunder Bay and Swastika). Although such height differences are modest they are encouraging in the light of possible additional gains from hybridization with those faster-growing provenances identified in established provenance trials.

Rooting of hard pine cuttings

In summer of 1978 a hard pine rooting experiment was started to determine whether the technique of girdling and application of a rooting powder would enhance rooting in hard-to-root pine species such as red pine, Austrian pine and pitch pine. If such treatments could induce rooting, graft incompatibility and rootstock x scion interactions would

IMPROVEMENT AND BREEDING CONIFEROUS TREE IMPROVEMENT AND BREEDING

be avoided. Treatment consisted of girdling a selected branch 5-7 cm below the apical bud and applying a rooting powder containing plant hormones, sucrose and a fungicide. Girdles were then wrapped with saran and aluminum foil. After 3 months branches were cut and placed in a mist bench, and checked periodically for presence of roots. Results showed that one Austrian pine clone rooted readily, but other Austrian, pitch and red pine clones did not. Further investigations on these species will be carried out in 1979.

Growth of Austrian pine under extended photoperiod

Germinated seedlings of Austrian pine (*Pinus nigra*) were grown under continuous high pressure sodium vapor lamps in the greenhouse for 3 months, and at the end of this period were compared with seedlings exposed to natural day length. Analysis of data showed that seedlings not exposed to continuous light were significantly taller. However, seedlings grown under light had diameters almost twice as large as untreated seedlings. Continuous light also seemed to hasten physiological phase changes - treated seedlings had all initiated secondary needles, while many of the untreated seedlings did not. Furthermore, needles on treated seedlings were more than twice as long as those on untreated seedlings. The implications of physiological phase change due to environmental stimuli are very interesting - such manipulations may lead to induction of early flowering in species which normally flower many years after germination. (Buchert)

Larch improvement program

Larch species trials were planted in the Ottawa, Cornwall and Fort Frances Districts. The stock was grown in tubes and was relatively small when field planted. As a result of the 1978 drought in the southern portion of the Province many of the small trees were lost during the summer. The experiment planted in the Fort Frances District was severely damaged by deer browse. An adjacent spruce planting was untouched.

CONIFEROUS TREE IMPROVEMENT AND BREEDING

Trials in which seed was germinated during the early months of 1978 included a stand trial of tamarack (*Larix laricina*) using seed from selected stands in the Eastern Region and a species trial containing several populations of *L. leptolepis*, *L. occidentalis* and *L. sibirica*.

Grafts of *L. leptolepis* were received from the Petawawa Forest Experiment Station during the fall of 1978. This material will be combined with additional grafted material from Maple of selected clones of both *L. decidua* and *L. leptolepis* over the next 3 years for the establishment of approximately 10 ha of a hybrid larch orchard in the Eastern Region. This program will be a cooperative venture with the Canadian Forestry Service and the Quebec Department of Lands and Forests.

Flower induction in larch Based on the results of flowering induction on some of our white spruce clones through gibberelin application, a trial was started on a young tamarack seed production area to see if similar results could be obtained for this species. The results will be obtained in the early spring of 1979.
(Rauter)

THE NORTHERN FOREST THE NORTHERN FOREST THE NORTHERN FOREST THE

Studies in the spruce-fir-aspen of northern Ontario concentrate on upland sites. The regeneration of spruces (reported in the chapter on Conifer Stock for Artificial Regeneration), management of balsam fir and quality and variation of aspen regeneration are the main programs undertaken by the Northern Forest Research Unit in Thunder Bay. The aspen program is once again under way. Other studies relating to the northern forest are mentioned in the chapters on Coniferous Tree Improvement and Breeding, and Site and Productivity.

Forest drainage and fertilization increase forest growth In 1969-70 a forest drainage-fertilization study was established by the District of Fort Frances with the cooperation of the Northern Forest Research Unit. The aim was to investigate the possibility of increasing the productivity of a black spruce swamp so that the trees could be economically harvested in the future. In 1977 an assessment was undertaken by a contract forester and a report has been prepared for review. Briefly, results indicated that growth of stagnating swamp black spruce can be accelerated by drainage but the amount is dependent upon a host of factors such as site quality, age of stand, method of ditching, stocking and intensity of ditching. Volume increases due to treatment ranged from 7 to 18% greater than controls. Larch occurring within the sample areas was found to respond much more rapidly than black spruce to treatment. Drainage (and fertilization) is a valuable silvicultural technique to improve swamp site productivity and may be a common practice in peatland areas, but further research is required if this technique is to be successfully applied.

Soil moisture on black spruce cutovers and plantations Monitoring of soil moisture continued on strip cuts and clear cuts in the Graham Working Circle in cooperation with Great Lakes Forest Products Ltd. This work will continue during the summer of 1979. During 1978 moisture and temperatures were also recorded in plantations of 26-year-old black spruce which were planted at 1.83 m and 3.66 m spacings. The plantations are located adjacent to the Thunder Bay Forest Station on deep, well- to medium-drained sand. Comparison of moisture regimes at 5 cm and 25 cm

NORTHERN FOREST THE NORTHERN FOREST THE NORTHERN FOREST THE NORTHERN

depths within the 1.83 m x 1.83 m spacing indicated that the 5 cm depth experienced higher moisture levels than the lower level throughout the frost free period. Under the 3.66 m x 3.66 m spacing the trend is reversed. Each stand was characterized by specific ground vegetation, namely, feather moss (*Pleurozium schreberi*) in the 1.83 m spacing stand and various species of grass in the 3.86 m spacing stand. If such relationships exist under other soil conditions, closer spacing in young black spruce plantations may be beneficial in encouraging the development of feather moss and the early growth of black spruce by the improvement of surface moisture conditions (and nutrition). Research will continue. (McClain)

Herbicides release balsam fir

Growth of immature (less than 3 m tall at time of spraying with a phenoxy herbicide) balsam fir (*Abies balsamea*) located on sandy, clay and silt loam sites improved significantly with treatment. Five years after spraying, root collar diameters of trees in sprayed areas exceeded those in control areas by 65%, 18% and 45% respectively on sand, clay and silt loam sites. By the tenth post-spray year, diameters of trees in sprayed and unsprayed stands on the clay silt loam sites differed by 63% and 67% respectively. On the silt loam sites, diameters of trees in treated and untreated stands differed by 66% and 62% after the fifteenth and twentieth post-spray years respectively. By the twentieth post-spray year, some trees had attained minimum pulpwood size. Tree heights in sprayed areas, on the average, five years after spraying were 47%, 19% and 51% greater than those on the control areas of sand, clay and silt loam sites respectively. By year 10, heights of trees in sprayed stands on the last 2 sites differed by 60% and 73% respectively from those in unsprayed stands. By the fifteenth and twentieth year, on silt loam sites trees in the sprayed area were respectively 74% and 66% taller than those in unsprayed stands. On the average, 5 years after spraying, balsam fir released exceeded controls by 153%, 51% and 165% in volume production respectively on sand, clay and silt loam sites. After 10 years, the respective differences for

FOREST THE NORTHERN FOREST THE NORTHERN FOREST THE NORTHERN FOREST

the last 2 sites were 179% and 260% larger. By the fifteenth and twentieth years, on silt loam sites volumes of trees in sprayed and unsprayed stands differed by 256% and 204%.

Balsam fir succession

Data collection and analyses to determine the extent of the balsam fir resource resulting from recent mechanical harvesting methods was deferred in 1978.

Thinning balsam fir

Tending research initiated in 1974 continued in 1978. Two new stands and 70 new plots were thinned to bring the stand and plot totals to 9 and 492 respectively. A progress report is being prepared.

Root decay and stain may not influence growth rate of balsam fir

Sampling to determine the initial incidence and level of root decay and stain in the 9 stands thinned by the Northern Forest Research Unit has been conducted by Dr R.D. Whitney of the Canadian Forestry Service. For approximately 500 trees, the levels of decay and decay plus stain have been established and causal organisms have been identified. Matching of growth rate and decay information has commenced. Preliminary indication from 40 pairs of decayed and decay-free trees has strongly indicated that *Armillaria mellea*, *Stereum sanguinolentum* and other root rot causing decay fungi do not alter and influence the growth rates of young decayed trees. Incorporation of the rest of the trees into the data analysis is underway to check the validity of the conclusions that growth losses due to disease are minor and disease is not a major drawback for balsam fir. (Lehela)

Quality and variability of aspen regeneration

Trials, established in 1976 and 1977, to determine if the timing and degree of scarification influence aspen (*Populus tremuloides* and *P. grandidentata*) suckering were reassessed in 1978. Preliminary results of scarification treatments applied the first growing season after harvest, and following initial sucker development suggested: 1/ spring scarification increased sucker density over the untreated control areas; 2/ fall scarification reduced sucker density compared to the control; 3/ heavy scarification in the spring or fall

THE NORTHERN FOREST THE NORTHERN FOREST THE NORTHERN FOREST

resulted in less sucker production than light scarification; and 4/ scarification reduced height growth, with heavy scarification producing the greatest reduction. These tentative results will be evaluated by continued monitoring of the areas.

A cooperative study, established in 1976 with the Great Lakes Forest Research Centre, to evaluate the growth and quality of surviving aspen suckers following herbicide application was continued in 1978. Nine years following treatment the height to the killed top was becoming difficult to ascertain. In some cases, only by sectioning the stem was the height of the top killed portion located. Ring counts above and below top killed portions indicated a maximum of 4 years and an average of 2 years top growth was lost, as a result of herbicide treatment. Comparisons of defect volumes and associated organisms in the control and treated trees will be made in 1979. (Weingartner)

UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST

The indigenous hardwood forest is an important component of the landscape and contributor to lifestyle in the southern half of the province. Many of the species provide valuable products under the right growing conditions. Studies, therefore, are directed to determination of these conditions. Work towards rehabilitation of lowland and upland sites is also undertaken in the southwest.

Yellow birch regeneration

A complete remeasurement was made of microplots in an 18-year-old regeneration cutting in the Swan Lake Research Reserve, Algonquin Park. Preliminary reduction of the data indicates that both sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*) have survived marginally better on unburned than burned seedbeds. Somewhat surprisingly, survival of sugar maple was poorer than that of yellow birch, not only from the point of overall survival (1.4% compared to 3.9%), but also on the basis of the percentage of originally stocked plots which have current survival values of at least 5% (i.e. 6.8% for maple, 32.3% for birch). This tends to confirm the view that restocking of maple is most readily achieved through advance growth rather than "de novo" regeneration. The low survival rate for yellow birch reflects an intense struggle for dominance under the better growing conditions, coupled with a high mortality and breakage loss under severely limited light budgets. Best yellow birch stems in the experiment exceeded 14 m in height (0.8 m/yr) and 12 cm dbh. Additional studies will be undertaken to explore the possible reasons for poor performance of maple regeneration on such a good site.

Quality dynamics of maple stands

Analysis continued on the quantification of complex defect patterns associated with natural wounding in cooperation with Dr J.T. Basham of the Great Lakes Forest Research Centre, Canadian Forestry Service. Branch stub data-arrays of 727 observation sets of 40 variables each were completed and entered into computer file. Good progress was made in fitting multiple regression models for wound healing and current tree growth. Further analysis is underway of variables dealing with wound and tree defect.

UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST UNDER-

Statistical analysis of the effect of healing on core microflora associated with maple stubs suggested that the kind of cultural result (i.e., sterile, bacteria, imperfect fungi, basidiomycetes) was strongly dependent upon the nature of the substrate (i.e., sound, stained, or decayed wood). This association was more pronounced for unhealed than healed wounds. Only isolations made from pith showed any significant dependence on healing status.

The microfloral diversity in maple stubs (i.e., percentage isolations vs percentage organisms) was redefined by fitting a modified logistic function to the data. This method is more precise and allows comparisons more readily than approximations made previously. Preliminary examination of stem wound data indicates that each wound type may require its own characteristic curve.

Computations were completed on the sound and defective volumes of naturally wounded maples. Values were obtained by one-foot (0.3 m) height intervals, allowing the calculation of volume (sound, stained or decayed) for any stem segment, for example in the vicinity of a stem wound, or for the butt log etc. In addition, wound surface area, degree of healing and callus volume increment were determined. These data are being prepared for computer input.

Data from an artificial wounding experiment with sugar maple showed that both tissue moisture content and pH value varied significantly in association with stem wounds. Depending upon time since infliction and tissue position relative to the wound, pH tended to increase and moisture to decrease compared to unwounded control positions. Tree reaction (defence mechanism) appears to play an important role in controlling the degree of change which takes place. Further analysis of the data is planned.

Recruitment dynamics of sugar maple

Sigmoidal height growth response curves developed by sugar maple advance regeneration released by various degrees of overwood partial cutting were fitted satisfactorily with Gompertz-type functions. Also, studies of clear-length development and self-pruning in pole-sized sugar maple

STANDING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST UNDERSTAND-

growing under a variety of stocking conditions were continued. Diameter increment data for sample trees and their competitors were collected to allow back-projections of stocking levels to ages at which release and/or defect (e.g., forking) occurred. Information was also gathered on the incidence and severity of epicormic branching and the relationship between bark characteristics and tree vigour. The intention of this study is to model the recruitment dynamics of sugar maple in relation to variation in stocking level in order to prescribe management procedures which will promote well-stocked, vigorous, high-quality ingrowth capable of sustaining or improving the value-production of stands.

Sugar maple decline

Five sugar maple sample trees were harvested from a stand exhibiting symptoms of maple decline in Keppel Township, near Owen Sound. This material, ranging from healthy, through partially dead, to recently dead specimens will be analyzed for strength, density, anatomical and mycological characteristics. Growth pattern will also be documented since previous observations have suggested that severely affected trees tended to have been decreasing in vigor for several years prior to symptom development.

Packaged information on tolerant hardwoods

Instructional courses and seminars were continued, mainly in the Algonquin Region. A slide-show package, complete with script, was prepared for the Algonquin Region which describes methods of defect appraisal in tolerant hardwoods. A submission on site requirements was prepared in connection with the proposed revision of the manual "Management of Tolerant Hardwoods in Algonquin Park". Additional revisions dealing with regeneration, vigor and defect are in preparation. (Anderson)

Stand development in the tolerant hardwood forest

Descriptive and measurement data are being analyzed to determine how stand structure, stocking and tree characteristics influence future development in the tolerant hardwood forest of the Algonquin area. It is apparent that no one stand or tree characteristic alone can be used to predict stand or

ING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING

individual tree development. The aim is to interpret and present the complex of factors in such a way that it will lend itself to application in silvicultural and forest management decisions. (McLean)

Growth analyses of black walnut Crown and stem development of black walnut (*Juglans nigra*) in a 40-year-old mixed walnut-pine plantation near Mount Salem in southwestern Ontario were analyzed. This was an expansion of a study by R. Fleming for a Master's degree thesis at the University of Toronto on the relative development of the species. The patterns of stem and branch development showed similarities to those reported earlier for sugar maple; a report will be prepared in 1979. The individual main horizontal roots of codominant black walnut in the plantation were estimated to be about 12 m in length and grew at the 20-30 cm depth. Fine laterals were common along their length. (Fayle)

Lowlands in southern Ontario Most of the effort in the lowland silvicultural research program during 1978 was devoted to establishing two major stand conversion experiments in two scrub poplar swamps; to computing the area of lowlands in southern Ontario where forestry, wildlife and recreation could be practised; and lastly to calculating the firewood, pulpwood and timber productivity of a 40-year-old silver maple (*Acer saccharinum*) stand in the Beverly swamp.

The stand conversion trials were designed to determine ways and means of upgrading scrub poplar stands with high quality, fast-growing silver maple, Jackii poplar, red ash (*Fraxinus rubra*) and European alder (*Alnus glutinosa*) selections.

Soil Conservation Authority and Statistics Canada reports indicated that there are approximately 7750 km² of lowlands in southern Ontario lying south of the precambrian shield. At \$495 per hectare, this land has an estimated value of 384 million dollars. The value for forestry, wildlife and recreation greatly exceeds this amount. For instance, the productivity of a second growth, 40-year-old silver maple

THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE

stand on a lowland site revealed that such a stand is capable of producing up to 718 m³ of firewood per hectare (80 standard cords of firewood per acre or 76 cords of pulpwood and 4 cords of firewood, or 22 600 board feet of lumber, 23 cords of pulpwood and 4 cords of firewood) in that time. Today, firewood is being sold from \$32 to \$50 a face cord, which gives a gross return of from \$18 980 to \$29 650 per hectare, amounting to \$495 to \$740 per hectare per year, which compares favourably with agricultural crops. (Larsson)

Elm breeding and propagation A collection of Dutch-elm-disease resistant American elm (*Ulmus americana*) and various hybrid elm trees is maintained, propagated and tested in disease-infected areas. A new method for cloning of elms by vegetative propagation of green-cuttings was successfully developed and a report presented to the Annual meeting of the International Plant Propagators Society. (Zsuffa)

Hardwood improvement on upland sites Over 2000 black alder seedlings raised from 10 select sources in 1978 were set out in a progeny/provenance trial. In Europe, the fast-growing species ranges from Norway to the Mediterranean regions showing an exceptional site tolerance and soil improving capacity. It is reported to have beneficial allelopathic effects on other species in mixed-wood plantations. Several black alder sources set out in southern Ontario small plantings 14 years ago produced trees measuring 20 m in height and over 30 cm at dbh. There were appreciable differences in performance among the individual progenies and provenances, a fact which should be carefully considered in establishing the species in Ontario.

Performance of white ash (*Fraxinus americana*) in progeny/provenance trials on open sandy outwash flats of the Tioga soils were less successful than those set out on the Guelph, Pike Lake or Vasey Soil Series on till uplands.

Black locust (*Robinia pseudoacacia*) showed considerable heterogeneity in growth rates, form, phenology and morphology. Trees of timber potential were identified and

HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE HARD-

marked for propagation. Lindane was used in controlling the locust borer. The damage by the latter appeared less predominant on the exposed rather than sheltered sites.

Stock of other hardwood species is being produced from select sources for experimental plantings.

Establishment on upland sites Pre-planting site preparation treatments in the Cambridge District were continued by combining several pre- and post-emergence herbicides in a single application. The area of about 9 ha was first cultivated and then allowed to resprout to a dense cover of weeds. Subsequent to spraying, there was some regrowth of ground vegetation which varied appreciably in species composition and abundance from treatment to treatment. Mortality of the planted trees as well as weeds was most pronounced on the dry, stoney ridges and was ascribed mainly to drought and percolation of the herbicides to the root zones, or both. The most susceptible tree species were sugar maple, yellow birch, black cherry (*Prunus serotina*), white ash and white pine. Lowest mortality occurred in European alder, red oak (*Quercus robur*), basswood (*Tilia americana*) and black walnut.

Foliar analyses were made for hardwoods grown on areas treated with herbicides during previous years. Similar analyses were also carried out for the major residual or re-invading weed species. The variations in foliar nutrient concentrations of the latter and the changes in composition and abundance of the ground cover subsequent to herbicide spraying have, undoubtedly, considerable influence on the development of the young tree seedlings. For this reason, chemical site preparation should be highly selective and adjusted to the needs of the individual planting sites. Work on this aspect is being continued.

On upland sites poplars are being tested as cover crops in establishing mixedwood plantations. There is sufficient indication that the various stock types have a definite bearing on both initial survival and growth of this species. In the long run, the surviving trees tend to equalize in

WOOD FOREST UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD

size on adequately prepared areas. Planting in sod restricted to herbicide treatments proved least successful particularly when using unrooted cuttings.

Diameter growth in sugar maple plots

Dendrometer tapes on about 200 sugar maple in heavily thinned, lightly thinned and control plots near Chatsworth, revealed a drastic reduction in diameter growth in both 1976 and 1977, probably due to heavy defoliation by the forest tent caterpillar (*Malacosoma disstria*). In 1978, no insect infestation was observed and the seasonal growth improved consistently and significantly for all diameter classes. (Jaciw)

Basswood to sugar maple regeneration

In 1968, basswood nursery stock was planted in 7 openings from 0.4 ha to 0.24 ha in size, following clearcutting in northern hardwoods in the Bancroft District, Algonquin Region. Ten-year growth of 315 basswood sample trees were measured in 1978.

Average height and diameter at breast height of the basswood was better in openings of 0.16 or 0.24 ha than of 0.04 or 0.08 ha; in easterly rather than southerly exposed openings; and better where the reproduction was dominated by sugar maple than striped maple or cherry. The best average height (3.8 m) and dbh (3.1 cm) occurred in an opening of 0.24 ha, dominated by sugar maple reproduction, and with an eastern exposure. Maximum height and diameter here were 5.5 m and 5.7 cm respectively.

Basswood is a desirable source of timber and rated higher in general tree quality than sugar maple. Its reproduction from seed is often absent and planting is justifiable to restore this species to its original level in hardwood cutover stands.

Oak to pine

An admixture of red oak to pine is part of one method of treating monocultures before their regeneration is completed. A series of plantings has been established to demonstrate the development of oak under various stand conditions. Some of these plantings were established in the Huronia District, Central Region, in the spring of 1976.

FOREST UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST

A jack pine stand, 50 years old, was thinned to basal areas of 7-17 m². Eleven 0.1 ha plots and two 0.4 ha plots, rectangular in size, were underplanted with 4000 red oak 3+0 nursery stock at a spacing of 1.8 m in rows 3.6 m apart. In a 50-year-old red pine stand, 5 circular openings and 2 rectangular openings from 0.02 to 0.04 ha in size were outplanted with 650 red oak 2+0 nursery stock at a spacing of 1.8 m by 1.8 m. The survival of the stock in both areas is about 92% after the third growing season and the development is good. A 28-year-old mixed red oak and red pine plantation is described in Forest Research Note No. 17. (Stroempl)

Maple sap studies

In 1978 the maple sap collecting season was 43 days in a sugar maple stand under study at Elmvale. The average sugar yield for 1 spile per tree (average dbh 41 cm) was 896 g as compared to 1511 g in 1977. The lower yield in 1978 was probably due to the random feeding of tent caterpillars which infested the sugar bush in 1976 and did considerable damage before being controlled by insecticides in 1977 and 1978. However, the average sugar concentration was higher in 1978 than in 1977, 2.0% compared to 1.8%. The greatest increase occurred in a dominant tree, from 1.5% in 1977 to 2.3% in 1978.

Increase in sugar yield in 1978 over controls, two years after initial fertilizer treatment in 1976, occurred only in intermediate crown class trees averaging 30 cm dbh. In this crown class the increase in sugar yield relative to the control for different fertilizer treatments was 50% for NPK, 29% for NP, 24% for N, 5% for NK. Dominant and co-dominant trees decreased in sugar yield relative to controls (Table 1). However, dominant trees treated with NPK still had the highest sugar yield, although this was not always associated with the highest sugar concentration or the fastest growth.

Consideration was given to the effect of lighting on the sugar yield and the accumulation of nutrients in maple sap, since dominant crown classes were exposed to an average

UNDERSTANDING THE HARDWOOD FOREST UNDERSTANDING THE HARDWOOD FOREST

TABLE 1 Relation between crown class, diameter growth and change in sugar yield in 1978 in 120-year-old sugar maple

| Treatments | Dominant | | Codominant | | Intermediate | |
|------------|-----------------------|----------------------|------------|---------|--------------|---------|
| | Growth % ^a | Yield % ^a | Growth % | Yield % | Growth % | Yield % |
| N | -22 | -21 | +80 | -32 | -3 | +24 |
| NP | +12 | -11 | -43 | -37 | +4 | +29 |
| NK | -31 | -28 | +40 | -29 | -42 | +5 |
| NPK | -12 | -8 | -5 | -28 | -36 | +50 |

^a $\frac{\text{Treatment-control}}{\text{control}} \times 100$

of 245 foot-candles and codominants to 120 foot-candles on one mid-June test day. On April 7, 1978, codominant trees having sugar concentration of 1.94% had 5 times as much N in their sap and only one third as much Ca as dominant trees, having a sugar concentration of 2.40%. On April 18, 1978, at a sugar concentration of 1.86%, the N concentration in the sap of codominant trees was even higher and the Ca concentration even lower than in dominant trees with sugar concentration of 2.14%.

The accumulation of K between April 7 and April 18 increased greatly in codominants but decreased slightly in dominants. The accumulation of P was slightly greater in codominant sap than in dominant sap but decreased slightly in both crown classes between April 7 and April 18.

In review, although N and P were much higher in codominant sap than in dominant sap, only N and K increased in codominants towards the beginning of the growing season, while P decreased as sugar concentration decreased also. Also, Ca was much lower in the codominant sap than in the dominant sap at the beginning of the growing season.

The difficulties of generalizing the conditions giving rise to higher sugar yields in sugar maple, suggest the segmentation approach may be more useful in establishing yield criteria than the customary use of an analysis of variance. (Leech)

SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY

With the intensification of forest management practices, it is important that the Ontario physiographic site classification be correlated with the Canadian system of soil classification. It is also desirable that field staff be able to assess site and soil conditions. To this end, field courses have been given and a kit developed for certain soil and foliar tests. The assessment and prediction of growth and yield for hardwoods and conifers continues, based on plot data and modeling techniques.

Soil and site classification

A program of correlation between the Ontario physiographic site classification system and the Canadian system of soil classification was initiated. This was greatly facilitated by the establishment, by Canada Agriculture, of a forest soils position within the Ontario Institute of Pedology at Guelph. The two classification systems are considered to be complementary, not competitive. Soil profile classification is the final step in the physiographic site classification system. It is particularly important to have proper description and correlation with the Canadian system, now that forest management practices are intensifying. Work is progressing in the comparison and correlation of classes used to describe key soil features, especially texture, drainage and moisture regime, and field guides to their recognition are being developed. Consideration is being given also to the classification of terrain needed for the evaluation and application of machinery in silviculture.

Site extension programs

In-service training and consulting in site recognition, classification and evaluation was provided to field management and other staff. In cooperation with the Ontario Centre for Remote Sensing, a 6-day site course and further field consultations were provided for the Northeastern region's site mapping program, and a 5-day site course was given for other staff of the Ministry. Professional support was also given to a practical soils course in the Eastern region. Lecturing on soils and site was provided for the Forest Management Certificate course and to students at

SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE

Lakehead University and the University of Toronto. Assistance was also given in the classification of plots within the federal government's root rot study in Northern Ontario. (Pierpoint)

Spot testing kit

Work on a spot testing kit begun in 1974 was completed except for some additional field testing. The kit should assist forest technicians in the preliminary examination of planting sites and in monitoring the use of chemicals in silviculture. On small managed areas less than 2 ha, the kit is intended to supply information such as soil pH, soil texture, and availability of soil nutrients. On managed areas larger than 2 ha, the kit should aid in determining the degree of soil sampling needed for laboratory analysis.

An accompanying spot testing manual introduces field tests for foliar nutrients which are lacking in routine analysis of soils. The tests for foliar N, P, K, Mg, Ca indicate the relative availability of these nutrients in the soil.

The first version of a short demonstration film on the use of the kit has been prepared. During 1979, the film and the kit will be demonstrated to field personnel having special problems in P availability or ion toxicity after the use of chemicals in silviculture. In the latter case, preliminary measurements of specific conductance indicate the need for frequent monitoring of the use of chemicals in the field. (Leech)

Plantation standards

An assessment and compilation was made of the results of numerous research plantations to produce empirical curves of survival, height, and aggregate height (m/ha) for the establishment period of plantations (0-20 years). It is hoped that these values may assist forest managers in assessing the performance of their plantations. Information has been published for white spruce and red pine (Forest Research Note No.'s 15 and 16) and will be published soon for white pine, black spruce and jack pine. These graphs

AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND

will be subject to modification by site and region in accord with local data. (Mullin)

Permanent sample plots in hardwoods and conifers Long-term projects have been started from time to time in differing forest types or working groups to provide information on the growth and yield of both natural and managed stands. Data collection during 1978 is indicated in Table 2.

Cooperative research projects in several districts have resulted in the establishment of sets of permanent sample plots in selected hardwood stands. Some of these are on Regional Forest properties but the greater number is on privately owned land, usually under Woodland Improvement Act agreements. The plots have been located so that they cover a range of stand density, usually from 12.5-28.5 m²/ha. In some cases the plots had to be thinned this year to the desired level of basal area. Information on the growth of stem wood volume on these plots is available to forest managers. As the data accumulate, it will be possible to create equations relating growth to various stand and site parameters.

TABLE 2 Distribution by districts of hardwood and conifer sample plots

| District | Sample plots measured | Plots thinned |
|-------------------------------|-----------------------|---------------|
| Hardwoods in southern Ontario | | |
| Huron | 30 | 14 |
| Niagara | 16 | - |
| Cambridge | 10 | 4 |
| Maple | 5 | 3 |
| Owen Sound | 6 | 6 |
| Bancroft | 10 | 4 |
| Tweed | 2 | - |
| Conifer plantations | | |
| Maple | 12 | 3 |
| Cornwall | 9 | 4 |
| Brockville | 4 | - |
| Simcoe | 16 | - |
| Lindsay | 21 | 3 |
| Conifer natural stands | | |
| Pembroke | 20 | - |
| Swastika | 5 | 3 |

PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND PRODUC-

Red pine tables refined

The ongoing collection of data on growth and yield of red pine plantations reached a plateau last year. Some of the oldest managed plantations had reached the site index age of 50 years. Preliminary tables of site index, total volume yield, stand basal area growth and growth in dominant height were made using multiple regression techniques.

These tables were refined through cooperative work with Prof V.G. Smith of the Faculty of Forestry and Landscape Architecture, Toronto, during 1978. Total stem volumes were re-calculated from scaling of individual trees cut during thinning operations. New yield and growth tables were constructed from the relationships established previously. New volume tables were also processed in cooperation with the Canadian Forestry Service.

An opportunity to augment the quality of similar growth data in mixed white and red pine plantations was presented through a survey of ice and snow damage at Northumberland Forest. Differences in growth rates between these mixed stands and pure red pine plantations are becoming more apparent with increasing age from planting. (Beckwith)

Thinning trials in natural white pine stands

With a renewing interest in growth of natural white pine stands some older thinning trials at Achray, Ontario were reassessed. The second-growth, 100-year-old age class represented in this study will be receiving increasing cutting pressure in the near future. The improved quality production resulting from mid-rotation low thinnings appears to be a necessary alternative to diameter limit cutting in this cover type. (Beckwith and Sinclair)

Ontario Wood Supply and Forest Produc- tivity model

A first-stage OWOSFOP model has been developed in collaboration with John Osborn and George Protich of the Management Planning Section, Timber Sales Branch. It derives empirical yield curves from the Forest Resources Inventory (FRI) data in FRI Reports 4 and 5, then uses them as surrogate growth curves to explore the long-term consequences of varied strategies in exploiting the wood supply expressed by Annual Allowable Cut (AAC). AAC may be calculated under area control, volume control or age control.

TIVITY SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY SITE AND PRODUCTIVITY

Although this first-stage model permits only a regeneration period of zero years, it clearly demonstrates the importance of successful regeneration of all cutover areas if continuity of supply is to be maintained. A second-stage model is being planned to permit variations in regeneration period and to allow changes in stand composition, whether the stands are cut or not.

Hardwood stand growth model

Analyses of M.M. McLean's data from selectively cut stands in and around Algonquin Park are continuing. The first objective will be to compare the growth responses found with those predicted by the several forms of his 1970 model (Stand Growth and Development after Partial Cutting in Tolerant Hardwoods). The second objective will be to develop a comparable model for such stands if partial cutting is excluded. (Raymond)

Productivity and nutrient cycling in spruce forest ecosystems

Studies of biomass, productivity, growth and nutrition, nutrient cycling, soil and vegetation sites, and regeneration in spruce forest ecosystems continue. (Gordon)

REQUESTS & COMMENTS Requests & Comments Requests & Comments

For convenience, this addressed card may be used to request publications listed on pages 7 - 10, to ask for further information about our research work, or to make any comments concerning FOREST RESEARCH 78.

- | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |

Circle appropriate number(s) above for publications and make any comments below.

From Address

.....

[illegible]

(Please print!)



The Head
Ontario Forest Research Centre
Ministry of Natural Resources
Maple, Ontario, Canada
LOJ 1E0

3 1761 11547569 1

